

SOLE

APPLICATION  
FOR  
UNITED STATES LETTERS PATENT

TO THE ASSISTANT COMMISSIONER FOR PATENTS:

BE IT KNOWN, that I,

**Han-Chin Lai**, Taichung, Taiwan

have invented certain new and useful improvements in **Sealing Mechanism for Diaphragm Tank** of which the following is a specification:

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# Sealing Mechanism for Diaphragm Tank

## **Field of the Invention**

This invention pertains to improvements for diaphragm expansion tanks, and, more particularly, to a mechanism to better seal the bladder of an expansion tank.

## **Background of the Invention**

5 A diaphragm tank 12 for potable water typically has a metal shell 22 and a plastic liner 24 (Figure 1). A diaphragm 26 is mounted below the liner 24, defining an air cushion between the shell 22 and the diaphragm 26 and an expandable bladder enclosed by diaphragm 26 and liner 24. A gasket 28 is usually mounted around the hole between  
10 the shell 22 and the liner 24 to stiffen the metal shell 22 and plastic liner 24 in the area of the hole and to form an airtight seal to block the leakage of air (Figure 2).

A connector 10 is mounted on diaphragm tank 12 to allow fluid to flow into or out of the tank (Figure 1). Connector 10 extends through both the shell 22 and the liner 24. A conventional connector includes a passage fitting 14 and an o-ring 16 mounted around  
15 the passage fitting 14 (Figure 2). The interior end of the passage fitting 14 is bent into a curled end 18 to retain the o-ring 16 on the passage fitting 14. A shoulder 20 abuts the outside of the tank 12, allowing the wall of tank 12 to be clamped between the shoulder 20 and the curled end 18 of the passage fitting 14.

The connector 10 links the tank to a water flow. When the pressure of the  
20 flowing water is greater than that of the air cushion, water flows into the bladder. When the water pressure decreases, the pressurized air in the tank expands against the bladder, pushing the water out until the air pressure is the same as the water pressure or the tank is empty.

As shown in Figure 2, a large force is required to press the curled end 18 around  
25 o-ring 16, and curled end 18 will easily be cracked. This reduces the pressure on o-ring 16, reducing its ability to seal the connector and reducing the strength of the passage fitting. In addition, the diameter of the contact area between the curled end 18 of the passage fitting 14 and the liner 24 is only slightly larger than the diameter of the hole,

allowing a gap to form between liner 24 and gasket 28. This allows air from the tank 12 to enter the water resident in the space between liner 24 and diaphragm 26. Because the air in the tank does not circulate, it may contain harmful bacteria and other microorganisms that could cause disease if air retained in the tank was allowed to mix  
5 with the water passing in and out of the bladder. As a result, it is desirable to have a more robust seal between the connector and the remainder of the tank.

### **Summary of the Invention**

In one aspect, the invention is a diaphragm tank. The tank comprises an outer shell, a flexible diaphragm, a liner sealingly connected to the flexible diaphragm to define  
10 a bladder and including an orifice and a raised portion surrounding the orifice that defines an annular groove, a passage fitting providing fluidic communication between an exterior of the outer shell and the bladder and having a neck, an o-ring disposed in the annular groove, an annular holder mounted on the passage fitting and having a groove and a gasket disposed between the liner and the outer shell. The annular holder is adapted to  
15 rest on the raised portion and retain the o-ring within the annular groove, and a portion of the neck is bent to retain the holder against the o-ring, thereby preventing fluidic communication between a space between the liner and the outer shell and the bladder along an outer wall of the passage fitting. The passage fitting may be disposed partially inside the outer shell and partially outside the outer shell and comprise a shoulder adapted  
20 to restrict motion of the passage fitting into diaphragm tank.

In another aspect, the invention is a diaphragm tank. The diaphragm tank comprises an outer shell, a flexible diaphragm, a liner sealingly connected to the flexible diaphragm to define a bladder and including an orifice and a raised portion surrounding the orifice that defines a relief surface, a passage fitting providing fluidic communication  
25 between an exterior of the outer shell and the bladder and having a neck, an o-ring disposed on the relief surface, an annular holder mounted on the passage fitting and having a groove, and a gasket disposed between the liner and the outer shell. The annular holder is adapted to retain the o-ring on the relief surface, and a portion of the neck is bent to retain the holder against the o-ring, thereby preventing fluidic communication

between a space between the liner and the outer shell and the bladder along an outer wall of the passage fitting.

In another aspect, the invention is a liner for use with a diaphragm tank and a through-wall connector, the through-wall connector comprising a passage fitting having a neck and adapted to extend into the diaphragm tank, an o-ring mounted on the passage fitting, an annular holder mounted on the passage fitting and having an annular groove, wherein the liner has a raised portion defining an annular groove to receive the o-ring, and, when the neck is bent over the holder, the annular groove on the holder fits around the raised portion and the o-ring, thereby preventing fluidic communication from an exterior side of the liner to an interior side of the liner along an outer surface of the passage fitting.

In another aspect, the invention is a liner for use with a diaphragm tank and a through-wall connector, the through-wall connector comprising a passage fitting having a neck and adapted to extend into the diaphragm tank, an o-ring mounted on the passage fitting, an annular holder mounted on the passage fitting and having an annular groove, wherein the liner has a raised portion having a relief surface on which the o-ring is disposed, and, when the neck is bent over the holder, the annular groove on the holder fits around the o-ring disposed on the relief surface of the passage fitting, thereby preventing fluidic communication from an exterior side of the liner to an interior side of the liner along an outer surface of the passage fitting.

### **Brief Description of the Drawing**

The invention is described with reference to the several figures of the drawing, in which,

**Figure 1** is a schematic view of a diaphragm tank with a conventional connector;

**Figure 2** is a cross-sectional view of the connector depicted in Figure 1;

**Figure 3A** is a partial cross-sectional view of a connector and tank according to an embodiment of the invention;

**Figure 3B** is a partial cross-sectional view of a connector and tank according to an alternative embodiment of the invention from that depicted in Figure 3A; and

**Figure 4** is an exploded prospective view of a liner according to an embodiment of the invention and a connector for use therewith.

#### **Detailed Description of Certain Preferred Embodiments**

The invention includes a liner for a diaphragm tank. In one embodiment, the liner  
5 30 rests inside the outer shell 22 of a diaphragm tank (Figure 3A). The liner 30 includes a  
raised portion 32 that defines an annular groove 34. An o-ring 36 disposed in groove 34  
provides a seal preventing fluidic communication between an expandable bladder defined  
by liner 30 and diaphragm 26 and the space between liner 30 and outer shell 22. In an  
alternative embodiment, groove 34 is omitted (Figure 3B). Rather, raised portion 32  
10 presents a relief surface 32a, *e.g.*, a surface elevated with respect to the neighboring  
portion of liner 30, on which o-ring 36 rests. The raised portion 32 defines an annulus  
that accommodates passage fitting 40.

The construction of diaphragm tanks is well known to those skilled in the art.  
Liner 30 is easily fabricated by injection molding, although alternative manufacturing  
15 techniques may be used. Exemplary materials for liner 30 include polypropylene, teflon,  
nylon, polyalkylene terephthalate, polyformaldehyde, polystyrene, poly(methyl  
methacrylate), polycarbonate, and poly(hexylisocyanate).

An exemplary connector for use with an embodiment of the present invention  
comprises a passage fitting 40, an o-ring 42 and an annular holder 44 (Figure 4). The  
20 passage fitting 40 extends through the outer shell 22 and liner 30 of the diaphragm tank.  
Passage fitting 40 may include a thread 46 that extends out from the tank to connect with  
a hose, pipe or other plumbing. One skilled in the art will recognize that the thread may  
also be tapped on the interior of passage fitting 40, or two threads may be included to  
provide flexibility in installation. The other end of passage fitting 40 defines a neck 48  
25 having an outer diameter smaller than the remainder of passage fitting 40. A shoulder 50  
at the inside extent of the thread 46 abuts the outer shell 22 of the diaphragm tank. A  
concave annular groove 52 in the holder 44 retains o-ring 42 in groove 34. To promote a  
watertight seal, the depth of groove 34 is less than the thickness of the o-ring 42.

To install the connector in the wall of a diaphragm tank, the neck 48 of passage fitting 40 is first inserted through the hole defined by the outer shell 22, gasket 28 and liner 30. O-ring 42 and holder 44 are sequentially mounted on neck 48. Neck 48 is then bent around holder 44. The bent neck 48 presses against the holder 44 to firmly retain the holder 44 in place. The shell 22, gasket 28 and liner 30 are tightly clamped between shoulder 50 of passage fitting 40 and holder 44. In addition, because the depth of the groove 34 is less than the thickness of the o-ring 42, the o-ring 42 will be deformed to expand against the outside of passage fitting 40 as it is squeezed between the holder 44 and the liner 30, providing a watertight seal. This forms a watertight seal at the junction of the liner 30 and passage fitting 40. In addition, liner 30 will be squeezed by the holder 44 to fully engage gasket 28, preventing leakage around the gasket.

Other embodiments of the invention will be apparent to those skilled in the art from a consideration of the specification or practice of the invention disclosed herein. It is intended that the specification and examples be considered as exemplary only, with the true scope and spirit of the invention being indicated by the following claims.

What is claimed is: